Engaging Students in Mathematical and Science Practices

NICOLE PAULSON, PROFESSIONAL DEVELOPMENT LEADER,
NICOLE.PAULSON@NEBO.EDU
NEBO SCHOOL DISTRICT
DECEMBER 5, 2013
ST. GEORGE, UT

Science and Engineering Practices

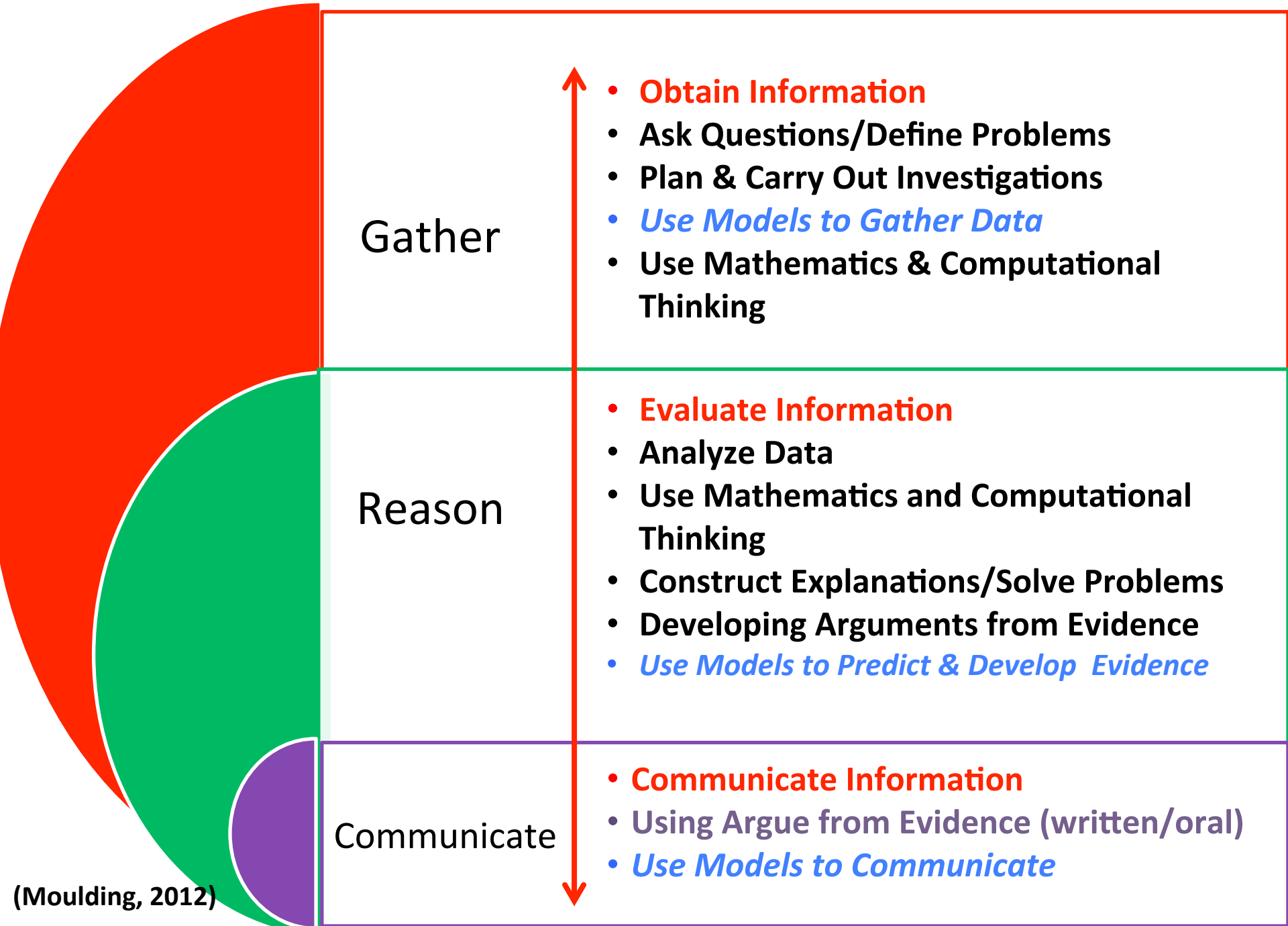
- Engaging in the practices of science helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the wide range of approaches that are used to investigate, model, and explain the world. Engaging in the practices of engineering likewise helps students understand the work of engineers, as well as the links between engineering and science.

- Participation in these practices helps students form an understanding of the crosscutting concepts and disciplinary ideas of science and engineering; moreover, it makes students' knowledge more meaningful and embeds it more deeply into their worldview.

Framework, Page 42

Science and Engineering Practices

1. Asking Questions (Science) and Defining Problems (Engineering)
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics, Information and Computer Technology, and Computational Thinking
6. Constructing Explanations (Science) and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information



(Moulding, 2012)

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
6. Attend to precision

2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others

4. Model with mathematics

5. Use appropriate tools strategically

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

Reasoning and explaining

Modeling and using tools

Seeing structure and generalizing

Overarching habits of mind of a productive mathematical thinker.

(McCallum, 2011)

Performance: Analyzing Data to Investigate Patterns and Support Explanations

Group Performance

1. **Investigate** the height a golf ball bounces off of a hard surface (concrete, tile) when dropped from various heights *(engineer ways to make accurate measurements).*
2. **Define the system** and **ask questions** about what **causes the observed patterns** in heights.
3. **Analyze data** and use representations to determine **patterns** and **mathematical relationships** for the data.
4. **Formulate questions** and **investigate explanations** for phenomena of the **pattern.**
5. Develop a **mathematical relationship** for the phenomena.

Individual Performance

6. Write in your journal or on note paper your **explanation** that may be used to explain this phenomena to others. Include **evidence** to support your **explanation** for why a pattern exists between the height of the drop and the bounce.

Discussion

Reflection

7. Reflect on the importance of **graphing data and using models** to make sense of phenomena.
8. Reflect on examples of other phenomena that have **patterns** and the **forces** that cause those patterns.

Teacher Reflection

- ✓ *Reflect on the nature of science instruction that supports students seeking **patterns** and using these **patterns** to make sense of "novel phenomena."*
- ✓ *Reflect on the importance of **graphing data and using models** to make sense of phenomena.*

Science and Engineering Practices

1. Asking Questions (Science) and Defining Problems (Engineering)
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematics, Information and Computer Technology, and Computational Thinking
6. Constructing Explanations (Science) and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

Science and Engineering Practices

4. Analyzing and Interpreting Data

- Once collected, data must be presented in a form that can reveal any patterns and relationships and that allows results to be communicated to others.
- Because raw data as such have little meaning, a major practice of scientists is to organize and interpret data through tabulating, graphing, or statistical analysis. Such analysis can bring out the meaning of data—and their relevance—so that they may be used as evidence.

Framework Pages 61-62

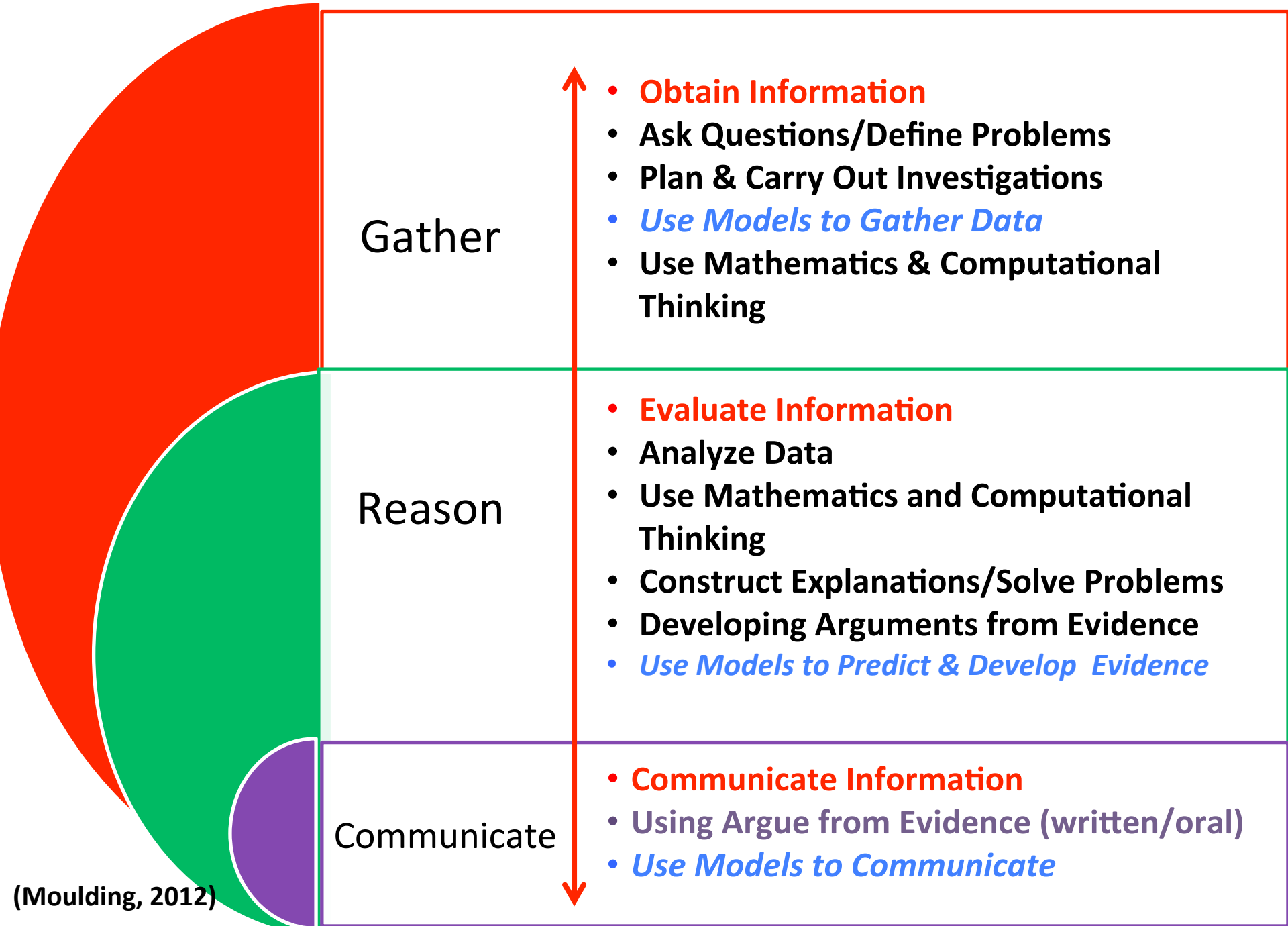
Science and Engineering Practices

4. Analyzing and Interpreting Data

- Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.
- Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.
- Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
- Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).
- Use data to evaluate and refine design solutions.

Science and Engineering Practices

5. Using Mathematics, Information and Computer Technology, and Computational Thinking
    - Organize simple data sets to reveal patterns that suggest relationships.
    - Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.
    - Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.



(Moulding, 2012)

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
6. Attend to precision

2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others

4. Model with mathematics

5. Use appropriate tools strategically

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

Reasoning and explaining

Modeling and using tools

Seeing structure and generalizing

Overarching habits of mind of a productive mathematical thinker.

(McCallum, 2011)

Science Performances

- Intersection of the Three Dimensions
  - Science and Engineering Practices
  - Disciplinary Core Ideas
  - Crosscutting Concepts

Discussion